EFFECTS OF STATIC AND DYNAMIC STRETCHING ON SPRINT AND JUMP PERFORMANCE IN BOYS AND GIRLS

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ABSTRACT

Paradisis, GP, Pappas, PT, Theodorou, AS, Zacharogiannis, EG, Skordilis, EK, and Smirniotou, AS. Effects of static and dynamic stretching on sprint and jump performance in boys and girls. J Strength Cond Res 28(1): 154–160, 2014—The aim of this study was to investigate the acute effects of static (SS) and dynamic stretching (DS) on explosive power, flexibility, and sprinting ability of adolescent boys and girls and to report possible gender interactions. Forty-seven active adolescent boys and girls were randomly tested after SS and DS of 40 seconds on quadriceps, hamstrings, hip extensors, and plantar flexors; no stretching was performed at the control condition. Pretreatment and posttreatment tests examined the effects of stretching on 20-m sprint run (20 m), countermovement jump (CMJ) height, and sit and reach flexibility test. In terms of performance, SS hindered 20 m and CMJ in boys and girls by 2.5 and 6.3%, respectively. Dynamic stretching had no effect on 20 m in boys and girls but impaired CMJ by 2.2%. In terms of flexibility, both SS and DS improved performance with SS being more beneficial (12.1%) compared with DS (6.5%). No gender interaction was found. It can therefore be concluded that SS significantly negates sprinting performance and explosive power in adolescent boys and girls, whereas DS deteriorates explosive power and has no effect on sprinting performance. This diversity of effects denotes that the mode of stretching used in adolescent boys and girls should be task specific.

KEY WORDS 20-m sprint run, countermovement jump, flexibility

INTRODUCTION

Traditionally, it is believed that stretching in the warm-up routines has significant benefits, including injury prevention and enhancement of athletic performance (40) by increasing both the body’s core temperature and the speed of neuromuscular responses (1). Based on these physiological responses, athletes have used extensive warm-up and stretch routines as part of their preparation for training and competition. However, there is much experimental evidence that does not support these beliefs, providing evidence that acute muscle stretching might be detrimental to performances whose success is related to maximal force or torque output (16,25,32,33,47). The reduction of performance has been linked to 2 main mechanisms. Mechanically, static stretching (SS) causes a decrease in musculotendinous unit (MTU) stiffness (45), leading to a lower rate of force production and a delay in muscle activation (11,25,26). This should result in an increase in tendon slack, which would require time to be taken in when the muscle attempts to contract (37), thereby leading to a less effective transfer of force from muscle to lever (25,44). Neurologically, stretching involves acute neural inhibition, resulting in an increase in autogenic inhibition, which decreases neural drive to the muscle (10,23,26), leading to a decrease in muscle activation after a muscle is stretched (18,43).

Even though the positive effects of stretching on flexibility are clear (2,3,35), there are some uncertainties regarding the effects of stretching on jumping performance. Some studies provide evidence of reduced performance (8,18,36,48), whereas others dispute this, showing no effects (33,35,36). Similarly, the relationship between pre-activity SS and sprint performance has not been investigated, and contrary results have been reported. Nelson et al. (34) found that SS negatively impacted 20-m sprint run (20 m) performance by 1.3% on 16 collegiate track athletes, conjecturing that both the above mechanical and neurological mechanisms contributed to the decrease in performance. Similar results (1.8% performance reduction) were reported by Fletcher and Jones (15) in a study of 97 male rugby union players, which were attributed to the above mechanical mechanism. Sayers et al. (39) also reported 2.0% increases in 30 m time after SS of 20 elite female soccer players. Contrary to these results, Vetter (42) found no effect of SS and dynamic stretching (DS) on 30 m performance of 26 college students, whereas Little and Williams (27) reported that pre-activity SS and DS improved 20 m performance by 1.7%.
Despite the controversies in the aforementioned studies, research to address the effect of stretching on sprinting and jumping performance of adolescent boys and girls is limited. The study by McNeal and Sands (30) is the only study that examined the effects of stretching on adolescents (13 girl gymnasts aged 13.3 ± 2.6 years), and they reported a reduction in drop jump by 9.6%, after 3 assisted stretching exercises lasting 30 seconds each. Under the prism of the reported uncertainties regarding sprinting and jumping performance after stretching in adult subjects, the purpose of this study was twofold; to compare the effects of SS and DS on explosive power, flexibility and sprinting performance in adolescent boys and girls, and determine whether the effects of stretching varied by gender. It was hypothesized that SS would result in significantly reduced sprinting and jumping performance but would lead to significantly improved flexibility. Given the difference in the stimulus associated with DS, it was hypothesized that the specific effects of DS might be different. Finally, it was hypothesized that both stretching strategies would produce the same results for both boys and girls.

**METHODS**

Experimental Approach to the Problem
To test the hypotheses of the study, the effects of 3 stretching protocols on sprinting, jumping performance, and flexibility were investigated. The 3 stretching protocols applied, no stretching (NS), SS, and DS, were chosen based on previous research (23,32,42,47). A within-subject experimental design was used, with all subjects completing the NS, SS, and DS protocols randomly. Pre-stretching and post-stretching tests were used to evaluate the effects of stretching on the selected dependent variables. For the evaluation of sprinting, jumping performance, and flexibility, the 20 m, countermovement jump (CMJ), and sit and reach (SR) tests were selected respectively. Data were collected across 6 test sessions separated by a 48- to 72-hour interval. During the data collection sessions, subjects performed a 5-minutes run (no stretching activities were performed) at a slow self-regulated pace, immediately followed by the pretests. After that, subjects performed 1 of the 3 stretching protocols (NS, SS, and DS) in a random order, immediately followed by the posttests. During the pretests and posttests, subjects performed either the CMJ and the SR tests or the 20 m in random order. The CMJ and SR were performed on the same testing day, whereas the 20 m was performed on different days to avoid any interaction effects and minimize testing time. The 20 m tests were measured using a TC-Timing System by Brower (Draper, UT, USA), CMJ was measured using a switch mat by Bosco (Rome, Italy), and SR was measured using a sit and reach box apparatus by Cranlea (Birmingham, United Kingdom). Subjects attended 3 familiarization sessions in which they were familiarized with the different stretching protocols and the tests, whereas on the last day, age, height, mass, and percentage of body fat were collected. All testing procedures took place in Fall, during the habitual practice time (1600–2000). During the testing period, subjects were asked to terminate any other sport activity and control their diet. The training facilities, where all familiarization and testing sessions took place, was well lit and kept under stable environmental conditions (temperature 258 C and humidity 52%).

Subjects
Forty-seven active adolescent boys and girls participated in this study (age, 14.6 ± 1.7 years; mass, 62.8 ± 12.4 kg; height, 1.68 ± 0.12 m; %body fat 19.95 ± 6.16%). All subjects were recreationally active in sports (2.0 ± 0.86 years training experience). Before participation, both subjects and their guardians received knowledge of the risks involved and signed an informed consent document. All procedures involved in this study were reviewed and approved by the university’s research ethics committee before initiation of the research.

Stretching Protocols
NS: Subjects were seated for 6 minutes and did not perform any stretching. SS: Subjects performed SS. Each subject stretched the target muscle of the left leg slowly and cautiously until a position of mild discomfort was reached for 20 seconds. Immediately after that, the procedure was repeated on the respective target muscle of the right leg. This sequence was performed twice. The next target muscle was stretched after a rest period of 15 seconds. The 4 muscle groups stretched were the quadriceps, hamstrings, hip extensors, and plantar flexors. DS: Subjects performed a DS. The subjects contracted the antagonist of the target muscle intentionally in standing upright position and flexed or extended some joints once every 2 seconds, so that the target muscle was stretched. This stretching was performed for 40 seconds. The procedure was performed firstly on the left leg and then on the right leg with a rest period of 15 seconds. The sequence of target muscle stretched and the rest periods was identical to that in SS. Quadriceps: The subjects contracted their hamstrings intentionally and flexed the knee joint so that the heel touched their buttock. Hamstrings: The subjects contracted the hip flexors intentionally with the knee extended and flexed their hip joint so that the leg was swung up to the anterior aspect of the body. Hip extensors: The subjects contracted hip flexors intentionally with the knee fixed and flexed their hip joint so that the thigh came up toward chest. Plantar flexors: Firstly, the subjects raised one foot from the floor and fully extended the knee. Then, they contracted their dorsiflexors intentionally and dorsiflexed the ankle joint so that the toe was pointing upward.

Tests
The fastest sprint, the highest jump, and the greatest flexibility score among the 3 trials were used for statistical analyses.

Sprint Run Test. The 20 m test started from an upright standing position (feet were approximately 8 cm apart with toes positioned on the 0-m start line, side by side, and...
Effects of Stretching on Sprint and Jump Performance

parallel with toes pointing directly forward; weight was shifted forward on the balls of the feet with the heel slightly disconnected from the ground), with hips and knees neither flexed nor rigid. Subjects were instructed to run as fast as possible for 20 m and not to brake until after passing the 20-m mark. A 5-minute rest intervened between the 3 runs. The best out of the 3 trials (in terms of time) was selected for further analysis.

Countermovement Jump Test. The ability of the subjects to produce force vertically was assessed with a CMJ: starting from an erect standing position, the downward countermovement was to a knee angle of approximately 90°. In all attempts, subjects kept their hands on their hips and performed 3 jumps. The height of rise of the center of mass of the body was calculated by using the formula \( d = \frac{v_i^2 t + \frac{1}{2} a t^2}{g} \) where \( v_i \) was the initial velocity, \( t \) was the flight time, and \( a \) the gravitational acceleration. This method of calculation assumes that the performer’s positions on the platform at takeoff and landing are identical. The best out of the 3 trials (in terms of height) was selected for further analysis. For the jump, the takeoff position had to meet the following criteria: maintain at least minimal heel contact to ground, have minimal hip flexion, and keep pre-reach arms straight, as described below.

Sit and Reach Test. The SR test was used to access the subject’s low back and hip joint flexibility. Each participant was seated on the floor with knees fully extended and ankles in neutral dorsiflexion against the box. Feet (shoes off) were placed flat against the box. The subjects leaned forward slowly as far as possible toward a graduated ruler held on the box from –25 to +25, without bending their knees and holding the greatest stretch for 2 seconds. The test was repeated 3 times, and the best score was recorded.

Statistical Analyses
Factorial analysis of variance (ANOVAs) with repeated measures \((2 \times 2 \times 3\) ANOVAs) were used to establish if there were any significant interactions between gender, time (pretest and posttests), and interventions (type of stretching). For all the ANOVAs, the assumption of sphericity was examined with the Mauchly’s test. In the event of significant interaction effects, post hoc Tukey tests were used to identify the differences. In addition, effect sizes, using the Cohen’s criterion \((d)\) (7) defined effect sizes as “small, \(d = 0.2\),” “medium, \(d = 0.5\),” and “large, \(d = 0.8\);” mean difference ± SD of pretest to posttest (MD) with 95% confidence interval of the differences (95% CI) and power estimation were used for data interpretation. Reliability was estimated with the interclass correlation coefficient (ICC). The significance level for the tests was set at \( p < 0.05\).

RESULTS

Reliability Analysis
The ICC was used to estimate the reliability of the dependent variables (20 m, CMJ and SR). The ICCs between pretesting and posttesting for 20 m were 0.930, 0.925, and 0.982; for CMJ were 0.993, 0.984, and 0.993; and for SR were 0.992, 0.984, and 0.991 for NS, SS, and DS, respectively. Furthermore, the Mauchly’s test examined the sphericity assumption for the valid application of the 2 \( \times 2 \times 3\) ANOVAs. The results were no significant for 20 m (Mauchly’s W = 0.952, \( p = 0.330\), CMJ (Mauchly’s W = 0.918, \( p = 0.147\), and SR (Mauchly’s W = 0.969, \( p = 0.490\) indicating no differences in the variances of differences between all possible pairs of groups.

| Table 1. Mean ± s and percentage differences (posttests – pretests) of 20 m, CMJ, and SR of all subjects \((N = 47)\) |
|-----------------|-----------------|-----------------|
|                  | 20 m (m)        | CMJ (cm)        | SR (cm)        |
| NS Pre           | 3.65 ± 0.27     | 28.35 ± 6.12    | 19.23 ± 9.75   |
| Post             | 3.63 ± 0.31     | 27.66 ± 6.255   | 20.23 ± 9.745  |
| \(\Delta\)%      | –0.6            | –2.6            | 5.2            |
| d                | 0.016           | 0.302           | 0.249          |
| SS Pre           | 3.64 ± 0.27     | 28.78 ± 5.99    | 19.17 ± 9.27   |
| Post             | 3.73 ± 0.31*    | 26.96 ± 5.88*   | 21.49 ± 9.26*  |
| \(\Delta\)%      | 2.5             | –6.3            | 12.1           |
| d                | 0.281           | 0.599           | 0.505          |
| DS Pre           | 3.63 ± 0.28     | 28.37 ± 6.22    | 20.34 ± 9.09   |
| Post             | 3.66 ± 0.29     | 27.74 ± 6.37*   | 21.66 ± 9.34*  |
| \(\Delta\)%      | 0.8             | –2.2            | 6.5            |
| d                | 0.143           | 0.273           | 0.372          |

*Significantly different from pretraining \((p < 0.05)\) as determined by repeated-measures analysis of variance and post hoc Tukey tests. CMJ = countermovement jump; SR = sit and reach; NS = no stretching; SS = static stretching; DS = dynamic stretching; \(\Delta\)% = percentage difference between pretest and posttest values.

20-m Sprint. The statistical analysis for the 20-m sprint revealed significant interaction effect between time and condition \((F = 7.029, p = 0.002, \eta^2 = 0.238, \text{ power} = 0.911)\). No significant effect for gender \((F = 3.641, p = 0.063)\) or any other significant interaction was recorded. With respect to the
time by condition effect, the three post hoc Tukey tests used to estimate differences between pretesting and posttesting for NS, SS, and DS revealed significance only for SS paired results comparison (NS: \( p > 0.05, \, d = 0.069; \) SS: \( p < 0.05, \, d = 0.310, \) MD = 0.095 + 0.15 seconds, 95% CI = 0.050–0.193 seconds; DS: \( p > 0.05, \, d = 0.105). \) After the SS protocol, 41 of 47 subjects increased the 20 m (range = 0.02–1.05 seconds) performance. The overall findings are presented in Tables 1 and 2.

**Countermovement Jump.** The statistical analysis for CMJ revealed significant interaction effect between time and condition (\( F = 10.399, \, p = 0.000, \, \eta_p^2 = 0.316, \) power = 0.983) and significant effect for gender (\( F = 14.608, \, p = 0.000, \, \eta_p^2 = 0.245, \) power = 0.962). No other significant interaction was recorded. With respect to the time by condition effect, the 3 post hoc Tukey tests used to estimate the differences between pretesting and posttesting for the NS, SS, and DS revealed significance for all comparisons by paired results (NS: \( p < 0.05, \, d = 0.103, \) MD = 1.000 + 1.757 cm, 95% CI = 0.484–1.586 cm; SS: \( p < 0.05, \, d = 0.250, \) MD = 2.319 + 2.323 cm, 95% CI = 1.637–3.001 cm; DS: \( p < 0.05, \, d = 0.143, \) MD = 1.319 + 1.733 cm, 95% CI = 0.810–1.828 cm). After the NS protocol, 25 of 47 subjects increased their CMJ (range = 1–9 cm); after the SS protocol, 37 subjects increased their SR (range = 1–10 cm); and after the DS protocol, 32 subjects decreased their SR (range = 1–6 cm). The overall findings are presented in Tables 1 and 2.

**Sit and Reach.** The statistical analysis for SR revealed significant interaction effect between time and condition (\( F = 5.947, \, p = 0.005, \, \eta_p^2 = 0.209, \) power = 0.857), and gender (\( F = 17.386, \, p = 0.000, \, \eta_p^2 = 0.279, \) power = 0.983). No other significant interaction was found. With respect to the time by condition effect, the 3 post hoc Tukey tests used to estimate the differences between pretesting and posttesting for the NS, SS, and DS protocols revealed significance for all comparisons by paired results (NS: \( p < 0.05, \, d = 0.103, \) MD = 1.000 + 1.757 cm, 95% CI = 0.484–1.586 cm; SS: \( p < 0.05, \, d = 0.250, \) MD = 2.319 + 2.323 cm, 95% CI = 1.637–3.001 cm; DS: \( p < 0.05, \, d = 0.143, \) MD = 1.319 + 1.733 cm, 95% CI = 0.810–1.828 cm). After the NS protocol, 25 of 47 subjects increased their SR (range = 1–9 cm); after the SS protocol, 37 subjects increased their SR (range = 1–10 cm); and after the DS protocol, 32 subjects decreased their SR (range = 1–6 cm). The overall findings are presented in Tables 1 and 2.

**Discussion**

The purpose of the present investigation was to compare the acute effects of stretching on sprinting, jumping performance, and flexibility in adolescent boys and girls. The results indicated that stretching significantly inhibited 20 m time performance in adolescent boys and girls. In particular, SS reduced 20 m performance by 2.5% compared with NS, which is in agreement with the results reported by Sayers et al. (39) and supports previous findings (14,15,22,31,34,46). However, Vetter (42) found no changes in the 30 m sprint time after 30-second SS protocols on 26 college students, whereas Little and Williams (27) reported that SS protocols improved 20 m time performance. These differentiations could be attributed to methodological issues. For example Vetter (42) stated that measuring sprint time with a stopwatch could cause inaccuracies, whereas, in the protocol used by Little and Williams (27) after stretching and before

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**Table 2. Mean ± s and percentage differences of 20 m, CMJ, and SR of boys (N = 17) and girls (N = 30).**

<table>
<thead>
<tr>
<th></th>
<th>20 m (m)</th>
<th>CMJ (cm)</th>
<th>SR (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Boys</td>
<td>Girls</td>
<td>Boys</td>
</tr>
<tr>
<td>NS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre</td>
<td>3.56 ± 0.33</td>
<td>3.70 ± 0.22</td>
<td>32.11 ± 7.44</td>
</tr>
<tr>
<td>Post</td>
<td>3.55 ± 0.32</td>
<td>3.67 ± 0.30</td>
<td>31.64 ± 7.36</td>
</tr>
<tr>
<td>Δ%</td>
<td>-0.3</td>
<td>-0.8</td>
<td>-1.4</td>
</tr>
<tr>
<td>SS</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Pre</td>
<td>3.55 ± 0.33</td>
<td>3.69 ± 0.22</td>
<td>33.09 ± 6.90</td>
</tr>
<tr>
<td>Post</td>
<td>3.60 ± 0.34</td>
<td>3.81 ± 0.26</td>
<td>30.81 ± 7.03</td>
</tr>
<tr>
<td>Δ%</td>
<td>1.4</td>
<td>3.2</td>
<td>-6.8</td>
</tr>
<tr>
<td>DS</td>
<td></td>
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</tr>
<tr>
<td>Pre</td>
<td>3.53 ± 0.35</td>
<td>3.69 ± 0.21</td>
<td>32.07 ± 7.69</td>
</tr>
<tr>
<td>Post</td>
<td>3.56 ± 0.33</td>
<td>3.72 ± 0.22</td>
<td>31.52 ± 7.88</td>
</tr>
<tr>
<td>Δ%</td>
<td>0.9</td>
<td>0.8</td>
<td>-1.7</td>
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</tbody>
</table>

*CMJ = countermovement jump; SR = sit and reach; NS = no stretching; SS = static stretching; DS = dynamic stretching; Δ% = percentage difference between pretest and posttest values.*
Effects of Stretching on Sprint and Jump Performance

20 m testing, subjects performed 8-minute warm-up and vertical jumping exercises. Another significant finding of the present study was the main effect for gender. The results indicated no difference for gender in terms of 20 m performance (even though the p = 0.063 value was close to significance level) and that SS and DS did not affect the genders differently (Table 2). The observation that DS did not affect performance in 20 m time in adolescent boys and girls compared with NS is in agreement with the results of Chaoauchi et al. (5), Vetter (42), and Mohammadtaghil et al. (31). However, other studies (15,17,27) found significant improvements in sprint performance. However, when comparing the results of SS to DS between adolescent boys and girls, it is clear that DS resulted to superior 20 m performance than to SS, which suggests that subjects performed better in 20 m when incorporating the DS within the warm-up protocol. This finding is consistent with previous studies (12,13,31) that have reported significant difference between SS and DS indicating that SS has more detrimental effect on 20 m compared with DS.

The results of this study revealed that SS acutely reduces CMJ performance by 6.3% in adolescent boys and girls, which agrees with the finding of McNeal and Sands (30) and supports previous studies in adults (4,8,9,20,47). However, other studies (23,24,35,38,41) reported no changes on jumping performance after SS, which could be attributed to the fact that these investigations used different protocols. However, DS acutely reduced CMJ performance by 2.2% in adolescent boys and girls in contradiction to other studies reporting no effect of DS (6,21,38,41) or positive effect (19,20) on CMJ performance in adults. However, the fact that CMJ performance was similarly reduced after NS indicates that other factors, than the effects of stretching, possibly played a role on this reduction, such as the age of the subjects. The main effect for gender revealed that boys produced significantly higher jumps than girls did; however, SS and DS did not affect the genders differently (Table 2).

In general, flexibility values were improved after NS (5.2%), SS (12.1%), and DS (6.5%) both in adolescent boys and girls. However, the measures of effect size for each condition revealed that the SS led to better flexibility than NS and DS. It is clear that DS is not as effective at increasing flexibility as SS in adolescent boys and girls. Hence, it could be important to include SS in the warm-up for specific sport flexibility applications. The results agreed with previous studies (2,16,33,35). The greater increase in flexibility after SS could be attributed to the viscoelastic stress relaxation that takes place when muscle tissue is kept stretched in a fixed position (28,29) or to an increased tendon elasticity and a decreased muscle viscosity, which produce a decreased passive joint torque (26). The main effect for gender revealed that girls produced significantly greater scores in the flexibility tests than boys; however, SS and DS did not affect the genders differently (Table 2).

Concluding, the present study provided kinematical evidence, that stretching during the warm-up routine produced significant acute decreases in performance in adolescent boys and girls. Static stretching resulted in a 2.5% overall acute decrease in 20 m time and a 6.3% decrease in CMJ, whereas SR was improved by 12.1%. The hypothesis that SS would result in significant acute reduced performance in 20 m and jumping but would lead to significant improved flexibility was supported. Dynamic stretching did not change 20 m time and produced a 2.2% decrease in CMJ, whereas improved SR by 6.5%. Dynamic stretching produced fewer changes in CMJ and SR than SS. The hypothesis that the specific effects of DS might be different than that of SS was supported. Finally, the hypothesis that both SS and DS strategies would produce the same results in both boys and girls was supported as SS and DS did not affect the genders differently. Mechanical (peripheral) and neurological (central) theories have been proposed as possible mechanisms regarding the decrease in performance caused by stretching. Jumping performance is an eccentric–concentric movement, whereas sprinting requires a continuous cycle of rapid transition from eccentric to concentric muscle action. During the eccentric phase, the series elastic component (SEC) lengths, storing elastic energy to be reused in the concentric phase of the stretch-shortening cycle, when the SEC springs back to its original configuration (39). Mechanically, as Fletcher and Jones (15) suggested, after a bout of SS, the SEC may already be lengthened, thereby impeding the preactivation of the MTU and decreasing its ability to store and reuse as much elastic energy during the stretch-shortening cycle. Additionally, because the amount of elastic energy that can be stored in the MTU is a function of stiffness and SS reduces the stiffness of the MTU, less elastic energy can be retained and used after a bout of SS (39), although some investigators (9) disagreed with that interpretation. However, neurologically, it has been suggested that stretching may cause neural inhibition (26,34,37), by inhibiting the myoelectric potentiation initiated during the eccentric phase of the stretch-shortening cycle, which is responsible for initiating muscle activation during the concentric phase. These mechanical and neurological mechanisms might have contributed to the decrease in performance during the eccentric–concentric phases of each stretch-shortening cycle, which affects the overall sprint performance. The results of the present study support the hypothesis that these mechanisms could be responsible for the decrease in 20 m performance.

Sayers et al. (39) reported that SS had a negative effect on the acceleration phase of the sprint and the maximal velocity phase of the sprint. Possible mechanisms responsible for that could be neurological (during both the acceleration and maximal velocity phases, the myoelectric potentiation may not be sufficient to produce a maximal response during the concentric phase), mechanical (a muscle that has been statically stretched has more slack than an unstretched muscle) or both. Additionally, Nelson et al. (34) found that SS resulted in decreased muscle strength endurance performance by placing some of the available motor units in a fatigue-like state therefore depleting the amount of motor units available.
for recruitment during the performance activity. This led to the onset of fatigue earlier in the activity and, therefore, to a decrease in performance. Given the repetitive use of several muscles during sprinting, this concept could be applied to sprinting action (14); however, whether a 20-m sprint is long enough for this particular mechanism to be considered is unknown. Further research is needed to identify which of these mechanisms (central or peripheral) is responsible for the deleterious effect of stretching and what extent each mechanism has on performance.

**Practical Applications**

Sprinting and explosive power performances are negatively affected if SS precedes these tasks. Therefore, SS should be avoided before these exercises. Dynamic stretching does not inhibit sprinting performance but deteriorates explosive power. Therefore, DS could be included before tasks that involve sprinting; however, it should be avoided before tasks that involve jumping. Both SS and DS improve flexibility, even though it seems the SS is more efficient compared with DS. This diversity of effects on stretching ability and performance denotes that the type of stretching used in boys and girls should be selected based on the task at hand. Nonetheless, it should not be ignored that athletes have accustomed themselves to include stretching in their warm-up routine. Thus, if someone acutely removes or reduces stretching from his or her usual warm-up routine, this could lead to a reverse effect (26), as athletes might feel unable to perform maximally without their “habitual routine.” It is feasible to suggest that in these ages, an alternative stretching approach should be introduced instead of distinguishing between the routine used for improving flexibility and the one used as part of the warm-up process targeting to activate the muscle groups involved in a specific performance task.

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Effects of Stretching on Sprint and Jump Performance


